CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A method for forming conductors with high electromigration resistance comprising the steps of

forming a layer of dielectric on a substrate,

forming at least one trench in said layer of dielectric,

forming a metal liner in said trench,

forming a conductor on said metal liner filling said trench,

forming a planarized upper surface of said conductor planar with the upper surface of said layer of dielectric, and

forming a conductive film over said upper surface of said conductor, said conductive film forming a metal to metal metallurgical bond.

2. The method of claim 1 wherein said step of forming a conductive film includes the step of forming said conductive film by electroless deposition whereby said upper surface of said conductor is protected from oxidation and corrosion and provides high electromigration resistance and high resistance to thermal stress voiding.

3. The method of claim 2 wherein said electroless deposited film has a thickness in the range of 1 to 20 nanometers.

4. The method of claim 2 wherein said electroless deposited film has a thickness in the range of 1 to 10 nanometers.

5. The method of claim 2 wherein said step of electroless deposition includes the steps of first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on said upper surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and hypophosphite ions whereby a metal-phosphide conductive film is formed on said upper surface of said conductor, and

annealing said substrate in one of an inert and reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film.

6. The method of claim 5 wherein said step of second immersing is omitted.

7. The method of claim 5 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, CoP, Pd, In and W and is in the range from 1 to 20 nm thick.

8. The method of claim 2 wherein said step of electroless deposition includes the steps of first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on the surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and dimethylamino borane whereby a layer of metal-boron conductive film is formed on said upper surface of said conductor, and

annealing said substrate in one of an inert and reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal boron conductive film.

9. The method of claim 1 wherein said conductive film is applied on the surface of said conductor by physical methods such as Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), evaporation, sputtering and thermal metal interdiffusion.

10. The method of claim 9 wherein said conductive film is selected from the group consisting of Pd, In, W and mixtures thereof.

11. A structure comprising:
a layer of dielectric on a substrate,
at least one trench formed in said dielectric on said substrate,
a metal liner formed in said trench,
a conductor on said liner filling said trench,
a planarized upper surface of said conductor with the upper surface of said layer of dielectric, and
a conductive film over said upper surface of said conductor, said conductive film forming a metal to metal chemical and metallurgical bond.

12. The structure of claim 11 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, CoP, Pd, CoB, CoSnB, CoWB, In, NiB and W whereby said upper surface of said conductor is protected from oxidation and corrosion.

13. The structure of claim 12 wherein said conductive film has a thickness in the range of 1 to 20 nm.

14. The structure of claim 12 further including an insulating cap dielectric layer over said conductive film on said conductor and said layer of dielectric.

15. The structure of claim 14 wherein said insulating dielectric cap layer is selected from the group consisting of silicon nitride, silicon oxide, insulating compounds of SICOH having dielectric constants less than 3.2, diamond-like carbon, fluorinated diamond like carbon and poly (Arylene ether).

16. The structure of claim 11 wherein said conductor is selected from the group consisting of copper and copper alloys.

17. The structure of claim 11 wherein said susbtrate is chosen from the group of silicon, silicon-germanium , SOI, and gallium arsenide.

18. A method for forming conductors with high electromigration resistance comprising the steps of

forming a patterned conductor on a substrate,

forming a conductive film over said surface of said conductor, said conductive film forming a metal to metal metallurgical bond.

19. The method of claim 18 wherein said step of forming a conductive film includes the step of forming said conductive film by electroless deposition whereby said surface of said conductor is protected from oxidation and corrosion and provides high electromigration resistance and high resistance to thermal stress voiding.

20. The method of claim 19 wherein said electroless deposited film has a thickness in the range of 1 to 20 nanometers.

21. The method of claim 19 wherein said electroless deposited film has a thickness in the range of 1 to 10 nanometers.

22. The method of claim 19 wherein said step of electroless deposition includes the steps of first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on said surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and hypophosphite ions whereby a metal-phosphide conductive film is formed on said surface of said conductor, and

annealing said substrate in one of an inert and reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film.

23. The method of claim 22 wherein said step of second immersing is omitted.

24. The method of claim 22 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, CoP, Pd, In and W and is in the range from 1 to 20 nm thick.

25. The method of claim 19 wherein said step of electroless deposition includes the steps of first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on the surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and dimethylamino borane whereby a layer of metal-boron conductive film is formed on said surface of said conductor, and

annealing said substrate in one of an inert and reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal boron conductive film.

26. The method of claim 18 wherein said conductive film is applied on the surface of said conductor by physical methods such as Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD) , evaporation, sputtering and thermal metal interdiffusion.

27. The method of claim 26 wherein said conductive film is selected from the group consisting of Pd, In, W and mixtures thereof.

28. A structure comprising:

a patterned conductor on a substrate,

a conductive film over said surface of said conductor, said conductive film forming a metal to metal metallurgical bond.

29. The structure of claim 28 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, CoP, Pd, CoB, CoSnB, CoWB, In, NiB and W whereby said upper surface of said conductor is protected from oxidation and corrosion.

30. The structure of claim 29 wherein said conductive film has a thickness in the range of 1 to 20 nm.

31. The structure of claim 29 further including an insulating cap dielectric layer over said conductive film on said conductor.

32. The structure of claim 31 wherein said insulating dielectric cap layer is selected from the group consisting of silicon nitride, silicon oxide, insulating compounds of SICOH having dielectric constants less than 3.2, diamond-like carbon, fluorinated diamond like carbon and poly (Arylene ether).

33. The structure of claim 29 wherein said conductor is selected from the group consisting of copper and copper alloys.

34. The structure of claim 29 wherein said susbtrate is chosen from the group of silicon, silicon-germanium, SOI, and gallium arsenide.

35. The method of claim 8 wherein said conductive film is selected from the group consisting of CoB, CoSnB, CoWB and NiB.

36. The method of claim 25 wherein said conductive film is selected from the group consisting of CoB, CoSnB, CoWB and NiB.